were exposed to sunlight. Welsh Clearwings were attracted to the lure at two of these sites. One had possible clearwing exit holes but the other, which attracted a single moth within 15 minutes and was 1.75km from the original site, had no evidence of clearwing exit holes; neither did any other trees in its immediate vicinity. This perhaps indicates that male Welsh Clearwing range widely when seeking virgin females. The number of sites at which the Welsh Clearwing was observed in a single day in the Trossachs suggest that the moth may occur at other suitable sites within central Scotland.

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Mating cluster behaviour in the solitary bee *Colletes succinctus* (Linn.), Hymenoptera, Colletidae

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In August 2005, during a botanical freshwater survey of the Water of Dye, a tributary of the River Dee at the Bridge of Bogendreip, Kincardineshire (NGR: NO 662910), our attention was drawn to the behaviour of a population of solitary bees. These bees were occupying plots of soil in the garden of Bogendreip Farm (Fig 1). Only in the last few years had Mr. Watt observed the bees and not previously, in his more than fifty years of farm occupancy. The bees were subsequently identified as *Colletes succinctus* (Linn.).

The bees had colonized extensive areas of sandy soils adjacent to the farmhouse, in which hundreds of individual nests formed two main "villages" with several adjacent smaller areas of colonization (Fig 1). We observed that the bees were displaying a form of aggregation behaviour during which a group of at least 6-8 individual males would surround an emerging female, forming a spherical structure (Fig 2). These groups of males assembled around a female for a period of 20-60 seconds, until presumably a successful mating had occurred, after which cluster formation would collapse, only to quickly reform, besieging another available female elsewhere in the population. The bees appeared so preoccupied with their activity that they remained unperturbed by our presence.

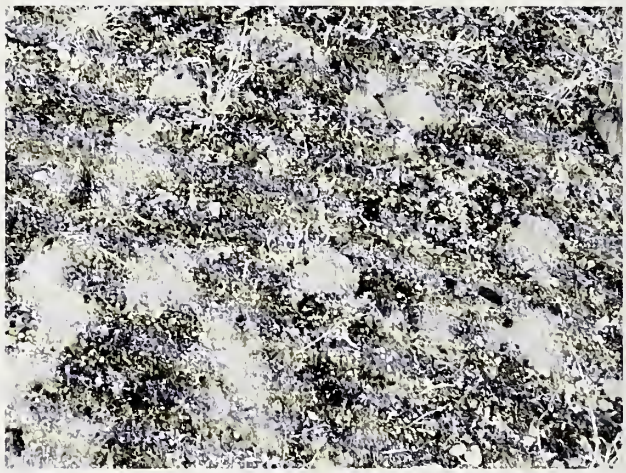

Fig. 1. Burrows of *Colletes succinctus* population.

To confirm species identification a small sample was collected in 2006 when the population reappeared. The identity was established from a male specimen whose morphological characters, including features in the genitalia, match those of *Colletes succinctus*, the girdled *Colletes* (Saunders, 1896; Step, 1946). This is a common species on heaths and commons and usually forages on heather.

Fig. 2. Mating cluster in *Colletes succinctus*.

A related species, *Colletes hederae* (Schmidt & Westrich), the ivy bee, has been observed to form small knots of males when competing for females. A coloured photograph of a small group is shown in Moenen (2005). Other species of the genus also exhibit mating clusters. They include *Colletes cunicularius* (Linn.) according to Larsson & Tengo

(1989), *C. thoracicus* Smith as described by Rajotte & Roberts (1980) and *C. perforator* Smith (Shimamoto, *et al.*, 2006). Mating clusters do not appear to have been reported before in *C. succinctus* but clearly this is part of the mating behaviour found widely in the genus.

Such mate-seeking behaviour has been widely observed in *Colletes cunicularius* males, lured to virgin females by olfactory signals; primarily the sex pheromone (*S*)-(+)-linalool (Cane & Tengo, 1981; Ayasse *et al.*, 2001; Borg-Karlson *et al.*, 2003; Mant *et al.*, 2005; Paxton, 2005). Emerging first, males patrol excitedly, often actively digging for receptive pre-emergent females at rendezvous sites around the general nesting area (Ayasse *et al.*, 2001; Borg-Karlson *et al.*, 2003; Paxton, 2005). A newly emerged female will be detected instantly by the patrolling males and become the centre of attention for the opportunity to mate with her. High numbers of males leads to an intense level of competition between males for copulation, as females are the limiting sex. This provokes 'scramble' behaviour as males pounce on an emerging virgin female, competing for the prime position for copulation (Ayasse *et al.*, 2001; Paxton, 2005). Once a fortunate male has begun copulating with the female (the interaction taking no more than a few minutes), the unsuccessful competitors are quick to disperse, continuing their search for a mate elsewhere in the nesting vicinity (Borg-Karlson *et al.*, 2003). The males, depending on their fitness, are polygynous, mating more than once with different females and the opportunities provided by the interesting biology of these bees is reflected in a number of studies (Larsson & Tengo, 1989; Rajotte & Roberts, 1980; Shimamoto, *et al.*, 2006). Solitary bee females are essentially monogamous, generally accepting only one mating and devoted to their investment in offspring production (Eichwort & Ginsberg, 1980; Ayasse *et al.*, 2001; Borg-Karlson *et al.*, 2003; Paxton, 2005). Post-copulation females become reduced in the male-attractant linalool thus losing their receptivity to males (Borg-Karlson *et al.*, 2003; Mant *et al.*, 2005; Paxton, 2005).

The behaviour has been referred to as mating clusters or 'polygynous scramble competition systems' (Larsson & Tengo, 1989) to distinguish it from 'balling' which is well known in *Apis mellifera* (Linn.), the honey bee (e.g. Robinson, 1984). In honey bees the behaviour is functionally different. Masses of worker bees will surround invading enemies and by raising the temperature, kill the intruder. Similarly, old queens are dispatched by this method when a new one emerges, the balling triggered by the release of a pheromone by the younger usurper.

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